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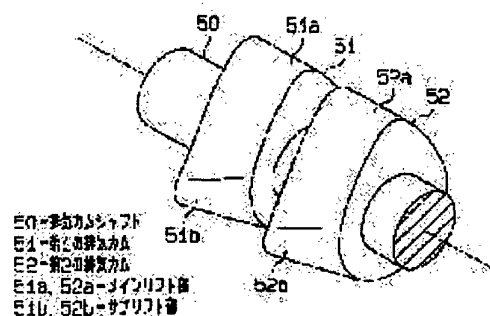
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(54) INTERNAL COMBUSTION ENGINE

(57)Abstract:

PROBLEM TO BE SOLVED: To restrain combustion from deteriorating caused by the uneven quality of the exhaust emission having been introduced into a combustion chamber in an internal combustion engine wherein exhaust emission is introduced into the combustion chamber by opening a pair of exhaust valves during an intake stroke.

SOLUTION: The internal combustion engine is provided with first and second exhaust valves arranged in a pair of exhaust ports individually connected to the combustion chamber, and first and second exhaust cams 51 and 52 provided at an exhaust cam shaft 50 to open and close the first and second exhaust valves respectively. These exhaust cams 51 and 52 are provided with main lift sections 51a and 52a to open and close their respective exhaust valves during an exhaust stroke and sub-lift sections 51b and 52b to open and close their respective exhaust valves during an intake stroke. The lifting quantity of the sub-lift section 51b in the first exhaust cam 51 is set larger than the lifting quantity of the sub-lift section 52b in the second exhaust cam 52.



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CLAIMS

[Claim(s)]

[Claim 1] The 1st exhaust valve which opens and closes the exhaust air port of the couple which leads to an engine combustion chamber, and the 2nd exhaust valve. The exhaust valve drive which makes each [these] exhaust valve open in an intake stroke, and makes exhaust air introduce into the aforementioned engine combustion chamber from the aforementioned exhaust air port. It is the internal combustion engine equipped with the above, and the aforementioned exhaust valve drive is characterized by carrying out an opening-and-closing drive with opening which is different in each aforementioned exhaust valve into an intake stroke that a revolution style should be formed in this engine combustion chamber by the exhaust air introduced into the aforementioned engine combustion chamber.

[Claim 2] The internal combustion engine which is characterized by providing the following and which was indicated to the claim 1. The aforementioned exhaust valve drive is the 2nd exhaust cam which carries out the opening-and-closing drive of the 1st exhaust cam and 2nd exhaust valve of the above which carry out the opening-and-closing drive of the 1st exhaust valve of the above. Each [these] exhaust cam.

[Claim 3] The internal combustion engine which is characterized by providing the following and which was indicated to the claim 2. It is a displacement means for each aforementioned sub lift section to be set up so that the amount of lifts may change continuously in accordance with the shaft orientations of the aforementioned cam shaft, and for the aforementioned exhaust valve drive to be constituted possible [the displacement to the shaft orientations] for the aforementioned cam shaft, and to carry out the variation rate of the cam shaft concerned to the shaft orientations further. Control means which control the amount of displacement by the aforementioned displacement means according to engine operational status.

[Claim 4] In the internal combustion engine indicated to the claim 3, the engine concerned is that to which the combustion gestalt is switched between stratification combustion and homogeneous combustion. the aforementioned control means when the aforementioned engine combustion gestalt is switched to stratification combustion, as compared with the time of this engine combustion gestalt being switched to homogeneous combustion, the difference of the amount of lifts in each aforementioned sub lift section becomes small -- as -- the above -- a variation rate -- the variation rate by the means -- the internal combustion engine characterized by being what controls an amount

[Claim 5] In the internal combustion engine indicated to a claim 2 or either of 4 the 1st exhaust cam of the above The amount of lifts in the aforementioned sub lift section is what is greatly set up as compared with the 2nd exhaust cam of the above. the 1st exhaust valve of the above The internal combustion engine characterized by having the fin which deflects the flow direction from the aforementioned exhaust air port on the occasion of the inflow of the exhaust air to the aforementioned engine combustion chamber so that it may be prepared in the portion located in the aforementioned exhaust air port side in the umbrella part and revolution of the exhaust air in the aforementioned engine combustion chamber may be promoted.

[Claim 6] The internal combustion engine which carries out [having further the inlet-valve drive which carries out an opening-and-closing drive into an intake stroke with opening which is different in each aforementioned inlet valve so that the inlet valve of the couple which opens and closes the suction port of the couple which leads to the aforementioned engine combustion chamber in the internal combustion engine indicated to a claim 1 or either of 5, and the revolution style of aforementioned exhaust air with inhalation air and the revolution style of this direction introduced into the aforementioned engine combustion chamber from each aforementioned suction port may be formed in this engine combustion chamber, and] as

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] This invention is equipped with the 1st exhaust valve which opens and closes the exhaust air port of the couple which leads to an engine combustion chamber, and the 2nd exhaust valve, and relates to the internal combustion engine makes each [these] exhaust valve open in an intake stroke, and it was made to make exhaust air introduce into an engine combustion chamber from an exhaust air port.

[0002]

[Description of the Prior Art] As a method of reducing the nitrogen oxide under exhaust air, the so-called exhaust gas recirculation (EGR:Exhaust Gas Recirculation) which makes a part of exhaust air mix in inhalation air is known. The equipment prepares the EGR path which connects a flueway and an inhalation-of-air path, make introduce a part of exhaust air in a flueway into an inhalation-of-air path through this EGR path, and it was made to make mix in inhalation air in order to perform such EGR is known well.

[0003] Moreover, the equipment returns a part of exhaust air to a combustion chamber from a flueway, and it was made to make mix in the inhalation air of this combustion chamber is also known by making an exhaust valve open temporarily in an intake stroke so that it may be indicated by JP,10-89033,A.

[0004]

[Problem(s) to be Solved by the Invention] By the way, in this combustion chamber, since exhaust air and inhalation air move in the inside of an inhalation-of-air path and flow into a combustion chamber when [both] it is made to make a part of exhaust air introduce into an inhalation-of-air path through an EGR path as mentioned above, where exhaust air and inhalation air are fully mixed, combustion comes to be performed.

[0005] However, with the equipment indicated by the above-mentioned official report, since exhaust air flows into a combustion chamber through a flueway apart from inhalation air, this exhaust air becomes is hard to be mixed in inhalation air and a combustion chamber. Consequently, if it was in this equipment, while exhaust air had not fully been mixed with inhalation air by it, combustion was performed, and there was a possibility of causing aggravation of a combustion state.

[0006] This invention is made in view of the above-mentioned actual condition, and the purpose is set to the internal combustion engine which is made to open the exhaust valve of a couple in an intake stroke, and introduced exhaust air at the engine combustion chamber, and is to suppress aggravation of the combustion state resulting from heterogeneous-ization of the exhaust air after the introduction.

[0007]

[Means for Solving the Problem] Hereafter, the means and its operation effect for attaining the above-mentioned purpose are indicated. The 1st exhaust valve which opens and closes the exhaust air port of the couple which leads to an engine combustion chamber in invention indicated to the claim 1, and the 2nd exhaust valve, In the internal combustion engine equipped with the exhaust valve drive which makes each [these] exhaust valve open in an intake stroke, and makes exhaust air introduce into the aforementioned engine combustion chamber from the aforementioned exhaust air port the aforementioned exhaust valve drive It is supposed that it is what carries out an opening-and-closing drive with opening which is different in each aforementioned exhaust valve in an intake stroke that a revolution style should be formed in this engine combustion chamber by the exhaust air introduced into the aforementioned engine combustion chamber.

[0008] According to the above-mentioned composition, the amount of the exhaust air introduced from one exhaust air port into an intake stroke in an engine combustion chamber increases more than the amount of the exhaust air introduced into an engine combustion chamber from the exhaust air port of another side by carrying out an opening-and-closing drive with the opening from which each exhaust valve differs. Consequently, the revolution style by

exhaust air comes to be formed in an engine combustion chamber. And by forming such a revolution style, mixture with exhaust air and the inhalation air of an engine combustion chamber can be promoted, and aggravation of the combustion state resulting from heterogeneous-ization of exhaust air can be suppressed now.

[0009] In the internal combustion engine indicated to the claim 1 by invention indicated to the claim 2 the aforementioned exhaust valve drive It has with the 2nd exhaust cam which carries out the opening-and-closing drive of the 1st exhaust cam and 2nd exhaust valve of the above which carry out the opening-and-closing drive of the 1st exhaust valve of the above, and the cam shaft in which each [these] exhaust cam was prepared. each aforementioned exhaust cam It has the main lift section which an exhaust air line makes open each aforementioned exhaust valve to inside, and the sub lift section which makes it open in an intake stroke, and it is supposed that it is what is constituted so that the amounts of lifts of these sub lift section may differ.

[0010] According to the above-mentioned composition, while each exhaust valve is opened [an exhaust air line] and closed by the main lift section in inside in addition to the operation effect of invention indicated to the claim 1, it sets in an intake stroke. EGR can be performed suppressing the influence which gives an exhaust air line to the valve-opening property of an inner exhaust valve as much as possible, in order for each exhaust valve to be opened and closed by the sub lift section prepared apart from this main lift section and for EGR to be performed.

[0011] In the internal combustion engine which indicated invention indicated to the claim 3 to the claim 2 each aforementioned sub lift section It is what is set up so that the amount of lifts may change continuously in accordance with the shaft orientations of the aforementioned cam shaft. the aforementioned exhaust valve drive the variation rate which the aforementioned cam shaft is constituted [variation rate] by the shaft orientations possible [displacement], and carries out the variation rate of the cam shaft concerned to the shaft orientations further -- a means and the above -- a variation rate -- the variation rate by the means -- it shall have the control means which control an amount according to engine operational status

[0012] according to the above-mentioned composition, based on engine operational status, it can control now appropriately from each exhaust air port by in addition to the operation effect of invention indicated to the claim 2, carrying out the variation rate of the cam shaft to the shaft orientations based on engine operational status, and changing the amount of lifts of the sub lift section, the amount of EGR(s), i.e., amount, of the exhaust air returned to an engine combustion chamber

[0013] Invention indicated to the claim 4 is that to which, as for the engine concerned, the combustion gestalt is switched between stratification combustion and homogeneous combustion in the indicated internal combustion engine claim 3. the aforementioned control means when the aforementioned engine combustion gestalt is switched to stratification combustion, as compared with the time of this engine combustion gestalt being switched to homogeneous combustion, the difference of the amount of lifts in each aforementioned sub lift section becomes small -- as -- the above -- a variation rate -- the variation rate by the means -- it is supposed that it is what controls an amount

[0014] It is made to form the mixed high gaseous layer of fuel concentration near the ignition plug by injecting fuel in a compression stroke at an engine combustion chamber in the internal combustion engine which performs stratification combustion. for this reason, the inside of the compression stroke which will follow this intake stroke if the revolution style of exhaust air is formed into an intake stroke at an engine combustion chamber -- setting -- the revolution style of the exhaust air -- the above -- there is concern which has a bad influence on stratification-ization of a gaseous mixture

[0015] Since the amount of displacement by the displacement means be make control so that the difference of the amount of lifts of each sub lift section become small as compared with the time of this engine combustion gestalt be switch to homogeneous combustion when the engine combustion gestalt be switch to stratification combustion , with the above-mentioned composition of invention which indicated to this point and the claim 4 , the intensity of the above-mentioned revolution style form of exhaust air at the time of stratification combustion come be stop .

[0016] Therefore, according to the above-mentioned composition, in addition to the operation effect of invention indicated to the claim 3, it can suppress that the revolution style of exhaust air has a bad influence on stratification-ization of a gaseous mixture at the time of stratification combustion as much as possible, and stable stratification combustion can be performed now.

[0017] In the internal combustion engine indicated to a claim 2 or either of 4 by invention indicated to the claim 5 the 1st exhaust cam of the above The amount of lifts in the aforementioned sub lift section is what is greatly set up as compared with the 2nd exhaust cam of the above. the 1st exhaust valve of the above It is supposed that it is what has the fin which deflects the flow direction from the aforementioned exhaust air port on the occasion of the inflow of the exhaust air to the aforementioned engine combustion chamber so that it may be prepared in the portion located in the aforementioned exhaust air port side in the umbrella part and revolution of the exhaust air in the aforementioned engine combustion chamber may be promoted.

[0018] According to the above-mentioned composition, in addition to the operation effect of invention indicated to a

claim 1 or either of 4, the revolution style of exhaust air can be strengthened with the above-mentioned fin prepared in the 1st exhaust valve, and mixture with exhaust air and inhalation air can be further promoted now. And since it is made to prepare the above-mentioned fin to the 1st exhaust valve with which the amount of the exhaust air which flows into an engine combustion chamber from an exhaust air port with the valve opening among each exhaust valve increases relatively, as compared with the composition which prepared this fin, the revolution style of exhaust air can be more effectively strengthened to the 2nd exhaust valve.

[0019] In the internal combustion engine indicated to a claim 1 or either of 5 by invention indicated to the claim 6 The inlet valve of the couple which opens and closes the suction port of the couple which leads to the aforementioned engine combustion chamber, It is made to have further the inlet-valve drive which carries out an opening-and-closing drive with opening which is different in each aforementioned inlet valve into an intake stroke so that the revolution style of aforementioned exhaust air with inhalation air and the revolution style of this direction which are introduced into the aforementioned engine combustion chamber from each aforementioned suction port may be formed in this engine combustion chamber.

[0020] According to the above-mentioned composition, by carrying out an opening-and-closing drive with the opening from which each inlet valve differs, the amount of the inhalation air introduced from one suction port into an intake stroke in an engine combustion chamber increases from the suction port of another side as compared with the amount of the inhalation air introduced into an engine combustion chamber, and the revolution style of exhaust air and the revolution style of the inhalation air which flows in this direction come to be formed in an engine combustion chamber. And in addition to the operation effect of invention indicated to a claim 1 or either of 5, mixture with exhaust air and inhalation air can be further promoted now by forming the revolution style of such inhalation air in an engine combustion chamber with the revolution style of exhaust air.

[0021]

[Embodiments of the Invention] The 1st operation gestalt of this invention is explained with reference to drawing 1 - drawing 6 below [the 1st operation gestalt].

[0022] Drawing 1 shows the cross-section structure in about 18 combustion chamber of an internal combustion engine 10, and drawing 2 shows the cross-section structure which met two to 2 line of this drawing 1. As shown in each [these] drawing, two or more cylinders (only one of them is shown in drawing 1) 15 are formed in the cylinder block 14 of an internal combustion engine 10, and the piston 16 is formed possible [reciprocation] in this cylinder 15. Partition formation of the combustion chamber 18 is carried out by these pistons 16, a cylinder 15, and the cylinder head 12 of an internal combustion engine 10.

[0023] The suction ports 33 and 34 of the couple which constitutes a part of inhalation-of-air path are formed in the cylinder head 12, and each [these] suction ports 33 and 34 are connected to the combustion chamber 18, respectively. Similarly the exhaust air ports 43 and 44 of the couple which constitutes a part of flueway are formed in the cylinder head 12, and each [these] exhaust air ports 43 and 44 are connected to the combustion chamber 18, respectively.

[0024] Furthermore, corresponding to each cylinder 15, the ignition plug 22 and the fuel injection valve 20 are attached in the cylinder head 12, respectively. In the internal combustion engine 10 of this operation gestalt, an engine combustion gestalt is switched between stratification combustion and homogeneous combustion based on the fuel injection timing of this fuel injection valve 20, and change of fuel oil consumption. That is, while fuel injection timing is set up in the second half of a compression stroke so that the mixed high gaseous layer of fuel concentration may be formed near the ignition plug 22 at the time of stratification combustion, fuel oil consumption is set up so that an air-fuel ratio may serve as RIN from theoretical air fuel ratio. On the other hand, while fuel injection timing is set up into an intake stroke so that a homogeneous mixed gaseous layer may be formed in a combustion chamber 18 at the time of homogeneous combustion, fuel oil consumption is set up so that an air-fuel ratio may serve as RIN from theoretical air fuel ratio or this theoretical air fuel ratio.

[0025] The openings 33a and 34a of each above-mentioned suction ports 33 and 34 are opened and closed by the 1st inlet valve 31 prepared in the cylinder head 12 possible [reciprocation], and the 2nd inlet valve 32, respectively. Similarly, the openings 43a and 44a of each exhaust air ports 43 and 44 are opened and closed, respectively with the 1st exhaust valve 41 prepared in the cylinder head 12 possible [reciprocation], and the 2nd exhaust valve 42.

[0026] Drawing 3 shows the drive which carries out the opening-and-closing drive of each above-mentioned exhaust valves 41 and 42. The exhaust air cam shaft 50 which constitutes a part of this drive is supported by the cylinder head 12 (this drawing illustration abbreviation) possible [rotation] possible [the displacement to the shaft orientations (henceforth "the direction of a cam shaft")]. The 1st exhaust cam 51 which opens and closes the 1st exhaust valve 41, and the 2nd exhaust cam 52 which open and close the 2nd exhaust valve 42 are formed in this exhaust air cam shaft 50 corresponding to each cylinder 15 (these 1st exhaust cams 51 and the 2nd one exhaust cam 52 are shown in drawing 3 , respectively). When each exhaust cams 51 and 52 rotate with the exhaust air cam shaft 50 and contact the valve lifter

(illustration abbreviation) of each exhaust valves 41 and 42, each exhaust valves 41 and 42 are opened and closed.

[0027] Drawing 4 expands and shows the exhaust cams 51 and 52 of these couples. Like the exhaust air line, the 1st exhaust cam 51 is equipped with main lift section 51a which makes the 1st exhaust valve 41 open to inside, and sub lift section 51b which makes this exhaust valve 41 open in an intake stroke, and is constituted. Moreover, like the exhaust air line, the 2nd exhaust cam 52 is equipped with main lift section 52a which makes the 2nd exhaust valve 42 open to inside, and sub lift section 52b which makes this exhaust valve 42 open in an intake stroke, and is constituted similarly.

[0028] By forming such the sub lift sections 51b and 52b in each exhaust cams 51 and 52, as shown in drawing 5, in an intake stroke, the 1st exhaust valve 41 (the opening change is shown in this drawing as a solid line) besides each inlet valves 31 and 32 and the 2nd exhaust valve 42 (the opening change is shown in this drawing with an alternate long and short dash line) also come to open based on the lift by the sub lift sections 51b and 52b, respectively. Incidentally, each valve-opening period of each exhaust valves 41 and 42 by these sub lift sections 51b and 52b is set up in the first half of an intake stroke with an exhaust pressure high enough.

[0029] Moreover, about the main lift sections 51a and 52a, the amount of lifts is uniformly set up along the above-mentioned cam shaft direction among the above-mentioned main lift sections 51a and 52a and the sub lift sections 51b and 52b. On the other hand, the sub lift sections 51b and 52b are set up so that the amount of lifts may change continuously along the direction of a cam shaft (refer to drawing 3 and drawing 4).

[0030] As shown in drawing 3, the oil hydraulic cylinder 60 to which the variation rate of this exhaust air cam shaft 50 is made to carry out in the direction of a cam shaft is formed in the edge of the exhaust air cam shaft 50. When the exhaust air cam shaft 50 displaces in the direction of a cam shaft based on the operation of this oil hydraulic cylinder 60, the amounts L1 and L2 (refer to drawing 5) of lifts in the sub lift sections 51b and 52b of each exhaust cams 51 and 52 change, it is based on the amount change of lifts, and the opening in the intake stroke of each exhaust valves 41 and 42 comes to be changed.

[0031] Drawing 6 shows the relation between the amounts L1 and L2 of lifts in the sub lift sections 51b and 52b of each exhaust cams 51 and 52, and the amount of displacement of the exhaust air cam shaft 50 in the direction of a cam shaft. As shown in this drawing 6, for the amount L1 (solid line) of lifts of the 1st exhaust cam 51, the amount L1 of the said lifts is maximum L1max. Except for the time of taking, it is set up so that it may become always large rather than the amount L2 (alternate long and short dash line) of lifts of the 2nd exhaust cam 52. Moreover, for difference $\Delta L (=L1-L2)$ of each [these] amounts L1 and L2 of lifts, the amounts L1 and L2 of these lifts are maximum L1max and L2max while being set up so that it may become so small that each amounts L1 and L2 of lifts become large. When taking, it is set up so that it may be set to "0" ($L1=L1max=L2max=L2$).

[0032] Moreover, operation of the above-mentioned oil hydraulic cylinder 60 is adjusted based on the pressure of the oil supplied from the hydraulic line 90 of an internal combustion engine 10. The solenoid valve 70 is formed in the oil pressure path between an oil hydraulic cylinder 60 and the above-mentioned hydraulic line 90 (illustration abbreviation), and the oil pressure supplied to the above-mentioned oil hydraulic cylinder 60 is controlled by switching the change position of this solenoid valve 70 based on an engine combustion gestalt or engine operational status (for example, engine rotational speed, an engine load, etc. which are detected by various sensors) by the control unit 80. And by controlling the supply oil pressure to an oil hydraulic cylinder 60 in this way, it comes to be controlled so that the amount L1 and L2 of displacement of the exhaust air cam shaft 50 of lifts, i.e., the amounts of each exhaust cams 51 and 52, suits an engine combustion gestalt and engine operational status.

[0033] For example, when the engine combustion gestalt is switched to homogeneous combustion, the amount D of displacement of the exhaust air cam shaft 50 comes to be controlled within the limits of the field R1 ($D1 < D < D3$) shown in drawing 6 based on engine operational status.

[0034] Here, when the amount D of displacement of the exhaust air cam shaft 50 is controlled by the range of ($D1 < D < D2$), the amount L2 of lifts of the 2nd exhaust cam 52 is smaller than bulb path clearance, and since only the amount L1 of lifts of the 1st exhaust cam 51 has exceeded this bulb path clearance, only the 1st exhaust cam 51 comes to open.

[0035] If the amount D of displacement of the exhaust air cam shaft 50 exceeds the predetermined value D2 and comes to be controlled within the limits of ($D2 < D < D3$), in order for the amounts L1 and L2 of lifts of each exhaust cams 51 and 52 to all exceed bulb path clearance on the other hand, both exhaust valves 41 and 42 of both come to open. However, in this case, in the amount L2 of lifts of the 2nd exhaust cam 52, since it is always small as compared with the amount L1 of lifts of the 1st exhaust cam 51 ($L2 < L1$), the opening of the 2nd exhaust valve 42 becomes small as compared with the opening of the 1st exhaust valve 41.

[0036] Thus, although only the 1st exhaust valve 41 opens or both exhaust valves 41 and 42 open among an intake stroke when the engine combustion gestalt is switched to homogeneous combustion, the 2nd exhaust valve 42 comes to

open with small opening as compared with the 1st exhaust valve 41. Therefore, more exhaust air comes to flow into a combustion chamber 18 as compared with the exhaust air port 44 of another side corresponding to the 2nd exhaust valve 42 from the exhaust air port 43 corresponding to the 1st exhaust valve 41.

[0037] Consequently, as an arrow shows the flow direction to drawing 2, the revolution style by exhaust air comes to be formed in a combustion chamber 18. And mixture with the inhalation air and exhaust air which are introduced into a combustion chamber 18 from each suction ports 33 and 34 comes to be promoted by forming the revolution style of such exhaust air.

[0038] On the other hand, when the engine combustion gestalt is switched to stratification combustion, the amount of displacement of the exhaust air cam shaft 50 comes to be controlled within the limits of the field R2 ($D4 < D < D5$) shown in drawing 6 based on engine operational status. In this case, as shown in this drawing, although the amounts L1 and L2 of lifts of each exhaust cams 51 and 52 are relatively set up greatly as compared with the case where the engine combustion gestalt is switched to homogeneous combustion, those difference ΔL is set up so that it may become small conversely. Therefore, the opening difference of each exhaust valves 41 and 42 becomes small as compared with the time of homogeneous combustion, and the intensity of the revolution style formed in a combustion chamber 18 of exhaust air can also be weakened now. Consequently, it can suppress now that stratification-ization of the gaseous mixture in a compression stroke is checked by the revolution style of the exhaust air formed in the combustion chamber 18 as much as possible.

[0039] In case according to the internal combustion engine 10 concerning this operation gestalt explained above the 1st exhaust valve 41 and the 2nd exhaust valve 42 are made to open temporarily and exhaust air is made to introduce in a combustion chamber 18 from each exhaust air ports 43 and 44 into (1) intake stroke. The revolution style of exhaust air was formed in the combustion chamber 18 by setting up the opening of the 1st exhaust valve 41 more greatly than the opening of the 2nd exhaust valve 42. For this reason, mixture with exhaust air and inhalation air can be promoted, and aggravation of the combustion state resulting from heterogeneous-ization of exhaust air can be suppressed now.

[0040] (2) Moreover, when an exhaust air line formed sub lift sections 51b and 52b with the another main lift sections 51a and 52a which open and close exhaust valves 41 and 42 in inside to each exhaust cams 51 and 52, each exhaust valves 41 and 42 are made to open in an intake stroke, and it was made to perform EGR. For this reason, EGR can be performed, suppressing the influence which gives an exhaust air line to the valve-opening property (a valve-opening stage, a valve-closing stage, or the degree of valve-opening) of each inner exhaust valves 41 and 42 as much as possible.

[0041] (3) While the amount of lifts furthermore made the above-mentioned sub lift sections 51b and 52b the 3-dimensional configuration which changes continuously along the direction of a cam shaft, the opening of each exhaust valves 41 and 42 in an intake stroke was controlled according to engine operational status by making the variation rate of the exhaust air cam shaft 50 carry out in the direction of a cam shaft with an oil hydraulic cylinder 60. For this reason, the amount (the amount of EGR(s)) of the exhaust air returned to a combustion chamber 18 can be appropriately controlled now based on engine operational status from each exhaust air ports 43 and 44.

[0042] (4) Moreover, when the engine combustion gestalt is switched to stratification combustion As compared with the case where it is switched to homogeneous combustion, so that the difference of the amount of lifts in each sub lift sections 51b and 52b may become small. When putting in another way, the intensity of the revolution style formed in a combustion chamber 18 of exhaust air was weakened by controlling the amount of displacement of the exhaust air cam shaft 50 so that the opening difference of each exhaust valves 41 and 42 in an intake stroke might become small. For this reason, the revolution style of such exhaust air can suppress having a bad influence on stratification-ization of the gaseous mixture in a compression stroke as much as possible, and can perform stable stratification combustion now. The operation effect of **** can be done now so.

[0043] Drawing 7 is combined, referred to and explained focusing on difference with the operation gestalt of the above 1st about [the 2nd operation gestalt], next the 2nd operation gestalt of this invention.

[0044] In the internal combustion engine 10 concerning this operation gestalt, in order to raise further the intensity of the revolution style formed in a combustion chamber 18 of exhaust air into an intake stroke, the point of making it prepare the fin which deflects the flow direction of the exhaust air which flows in a combustion chamber 18 from the exhaust air port 43 in the 1st exhaust valve 41 of the above is different from the 1st operation gestalt.

[0045] Drawing 7 shows the tropia structure of the 1st exhaust valve 41 in this operation gestalt in which the above-mentioned fin was prepared. As this fin 45 surrounds the periphery of stem 41a of the 1st exhaust valve 41, it is prepared in the field located in the exhaust air port 43 side in umbrella part 41b of this exhaust valve 41. [two or more] These fins 45 are arranged so that a radial may be made focusing on stem 41a while being set up along the direction of an axis of stem 41a from the rear face of umbrella part 41b. Moreover, it is gradually bent from the portion located in the stem 41a side, covering [these / 45] it over the portion located in the periphery side of umbrella part

41b, and it is formed so that the whole may make the shape of an abbreviation segment.

[0046] By forming such a fin 45 in the 1st exhaust valve 41, the exhaust air which flows from the exhaust air port 43 into an intake stroke with valve opening of the 1st exhaust valve 41 in a combustion chamber 18 comes to flow between each fin 45, and the flow direction comes to be deflected in the direction in which only the predetermined angle inclined to the direction of a path of umbrella part 41b with each fin 45. Consequently, the revolution force is given to the exhaust air which flows in a combustion chamber 18, and the intensity of the revolution style of this exhaust air comes to be raised.

[0047] Therefore, according to the internal combustion engine 10 concerning this operation gestalt, in addition to the operation effect indicated to (1) - (4) in the 1st operation gestalt, the revolution style of exhaust air can be strengthened with the above-mentioned fin 45 prepared in the (5) 1st exhaust valve 41, and mixture with exhaust air and inhalation air can be further promoted now. And since it is made for the amount of the exhaust air which flows into an engine combustion chamber with the valve opening among each exhaust valves 41 and 42 to form a fin 45 to many 1st exhaust valve 41 relatively, as compared with the composition which prepared such a fin in the 2nd exhaust valve 42, the revolution style of exhaust air can be strengthened more effectively. The said operation effect can be further done now so.

[0048] Drawing 8 and drawing 9 are combined, referred to and explained focusing on difference with the operation gestalt of the above 1st about [the 3rd operation gestalt], next the 3rd operation gestalt of this invention. In addition, drawing 9 is the cross section which met two to 2 line of drawing 1 like previous drawing 2.

[0049] In addition to the revolution style of above-mentioned exhaust air, in the internal combustion engine 10 concerning this operation gestalt, the point it is made to form the revolution style of inhalation air in a combustion chamber 18 is different from the 1st operation gestalt by having the drive which carries out the opening-and-closing drive of each inlet valves 31 and 32 with different opening in an intake stroke.

[0050] The drive of these inlet valves 31 and 32 is constituted by the air inlet cam (illustration abbreviation) of the couple which opens and closes each inlet valves 31 and 32, and the inhalation-of-air cam shaft (illustration abbreviation) in which these air inlet cams were prepared. And the cam profile is set up so that the air inlet cam which opens and closes the 1st inlet valve 31 among these air inlet cams may become small partially rather than the air inlet cam to which the amount of lifts opens and closes the 2nd inlet valve 32.

[0051] Therefore, from from, as shown in drawing 8, as the opening (alternate long and short dash line) is an intake stroke, it comes to close the 1st inlet valve 31 earlier than this inlet valve 32 while becoming smaller than the opening (solid line) of the 2nd inlet valve 32.

[0052] For this reason, as compared with the suction port 33 of another side corresponding to the 1st inlet valve 31 from a suction port 34 corresponding to the 2nd inlet valve 32, more inhalation air comes to flow into an intake stroke in a combustion chamber 18. Consequently, as the arrow of an alternate long and short dash line shows the flow direction to drawing 9, a revolution style with inhalation air comes to be formed in a combustion chamber 18.

Moreover, since opening 34a of the above-mentioned suction port 34 is located on opening 43a of the exhaust air port 43 corresponding to the 1st exhaust valve 41, and a vertical angle, the revolution style with the inhalation air comes to flow in the revolution style (the arrow of a solid line shows the flow direction to drawing 9) and this direction of exhaust air.

[0053] Therefore, according to the internal combustion engine 10 concerning this operation gestalt, it adds to the operation effect indicated to (1) - (4) in the 1st operation gestalt. (6) by having formed the revolution style of above-mentioned exhaust air, and the revolution style of the inhalation air which flows in this direction in the combustion chamber 18 by setting up the opening of the 2nd inlet valve 32 more greatly than the opening of the 1st inlet valve 31 Mixture with exhaust air and inhalation air can be promoted further, and aggravation of the combustion state resulting from heterogeneous-ization of exhaust air can be more certainly suppressed now. The said operation effect can be further done now so.

[0054] Each operation gestalt explained above can also change and carry out composition as follows.

- although the oil hydraulic cylinder 60 was used with each above-mentioned operation gestalt as an actuator to which the variation rate of the exhaust air cam shaft 50 is made to carry out in the direction of a cam shaft -- electromagnetism -- you may make it adopt the actuator of a solenoid formula or a pneumatic pressure formula

[0055] - although the cam mechanism was adopted with each above-mentioned operation form as a mechanism in which each inlet valves 31 and 32 and exhaust valves 41 and 42 are driven -- these inlet valves 31 and 32 and exhaust valves 41 and 42 -- electromagnetism -- it can also constitute as a drive valve

[0056] - You may make it apply the fin 45 explained in the 2nd operation gestalt to the internal combustion engine 10 concerning the 3rd operation gestalt.

- Although the above-mentioned fin 45 was formed only in the 1st exhaust valve 41 with the 2nd operation gestalt, you

may make it prepare the same fin also as the 2nd exhaust valve 42.

[0057] - While constituting one side among each air inlet cam as a 3-dimensional cam from which a lift configuration changes to the shaft orientations of an inhalation-of-air cam shaft, you may make it control the opening difference of inlet valves 31 and 32 in the 3rd operation gestalt by carrying out the variation rate of the inhalation-of-air cam shaft to the shaft orientations according to engine operational status.

[Translation done.]

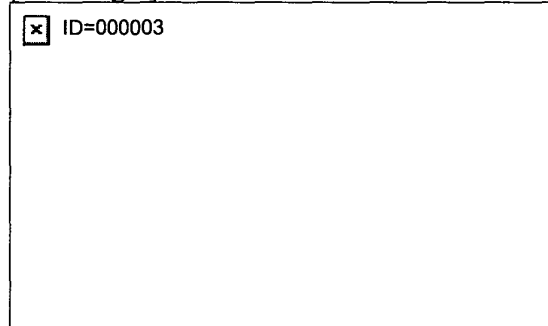
* NOTICES *

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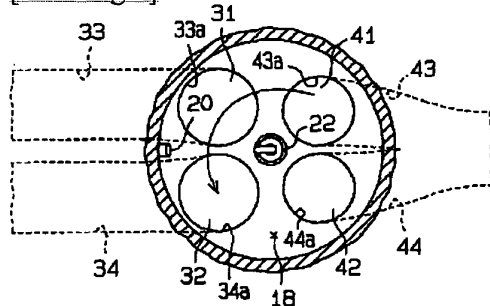
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DRAWINGS

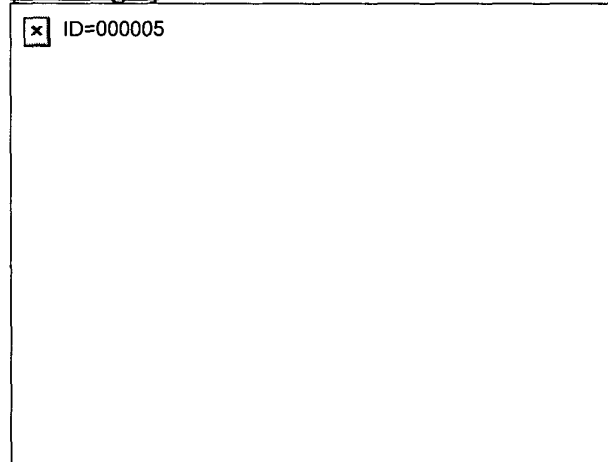
[Drawing 1]



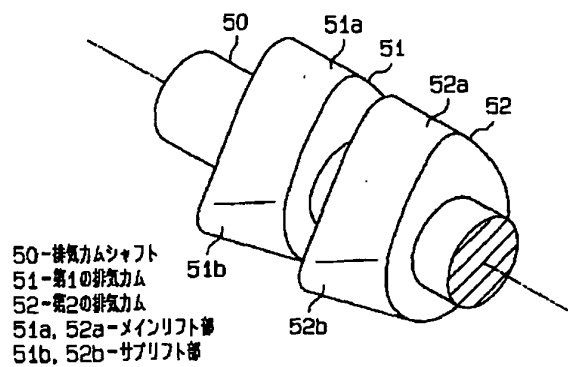
[Drawing 2]



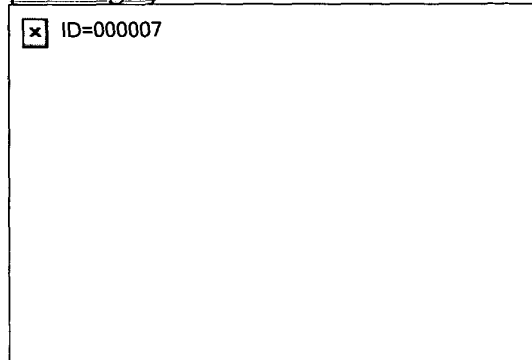
[Drawing 3]



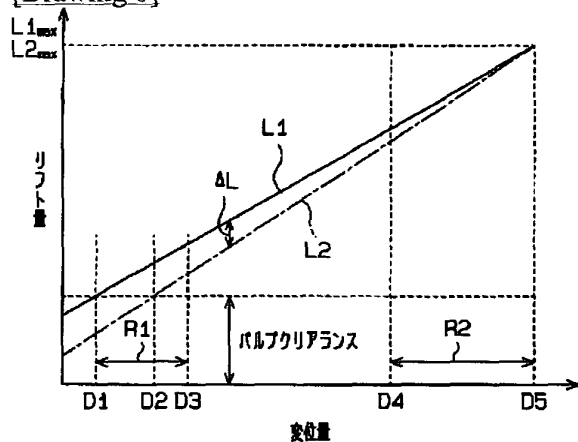
[Drawing 4]



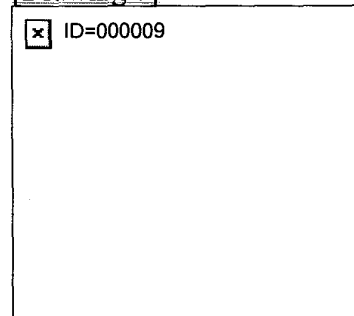
[Drawing 5]



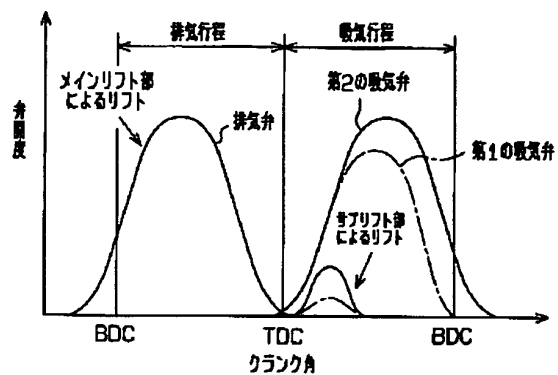
[Drawing 6]



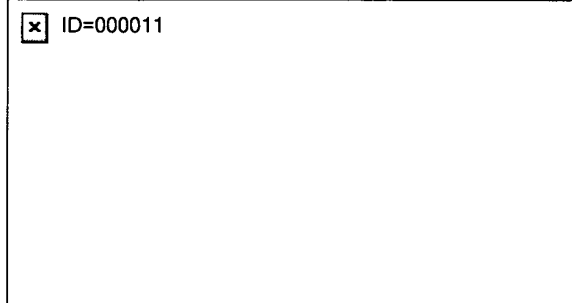
[Drawing 7]



[Drawing 8]



[Drawing 9]



[Translation done.]